Key Terms

action potential electrical signal that moves down the neuron's axon

adrenal gland sits atop our kidneys and secretes hormones involved in the stress response

agonist drug that mimics or strengthens the effects of a neurotransmitter

all-or-none phenomenon that incoming signal from another neuron is either sufficient or insufficient to reach the threshold of excitation

allele specific version of a gene

amygdala structure in the limbic system involved in our experience of emotion and tying emotional meaning to our memories

antagonist drug that blocks or impedes the normal activity of a given neurotransmitter

auditory cortex strip of cortex in the temporal lobe that is responsible for processing auditory information

autonomic nervous system controls our internal organs and glands

axon major extension of the soma

Broca's area region in the left hemisphere that is essential for language production

biological perspective view that psychological disorders like depression and schizophrenia are associated with imbalances in one or more neurotransmitter systems

central nervous system (CNS) brain and spinal cord

cerebellum hindbrain structure that controls our balance, coordination, movement, and motor skills, and it is thought to be important in processing some types of memory

cerebral cortex surface of the brain that is associated with our highest mental capabilities

chromosome long strand of genetic information

computerized tomography (CT) scan imaging technique in which a computer coordinates and integrates multiple x-rays of a given area

corpus callosum thick band of neural fibers connecting the brain's two hemispheres

dendrite branch-like extension of the soma that receives incoming signals from other neurons

deoxyribonucleic acid (DNA) helix-shaped molecule made of nucleotide base pairs

diabetes disease related to insufficient insulin production

dominant allele allele whose phenotype will be expressed in an individual that possesses that allele

electroencephalography (EEG) recording the electrical activity of the brain via electrodes on the scalp

endocrine system series of glands that produce chemical substances known as hormones

epigenetics study of gene-environment interactions, such as how the same genotype leads to different phenotypes

fight or flight response activation of the sympathetic division of the autonomic nervous system, allowing access to energy reserves and heightened sensory capacity so that we might fight off a given threat or run away to safety

forebrain largest part of the brain, containing the cerebral cortex, the thalamus, and the limbic system, among other structures

fraternal twins twins who develop from two different eggs fertilized by different sperm, so their genetic material varies the same as in non-twin siblings

frontal lobe part of the cerebral cortex involved in reasoning, motor control, emotion, and language; contains motor cortex

functional magnetic resonance imaging (fMRI) MRI that shows changes in metabolic activity over time

gene sequence of DNA that controls or partially controls physical characteristics

genetic environmental correlation view of gene-environment interaction that asserts our genes affect our environment, and our environment influences the expression of our genes

genotype genetic makeup of an individual

glial cell nervous system cell that provides physical and metabolic support to neurons, including neuronal insulation and communication, and nutrient and waste transport

gonad secretes sexual hormones, which are important for successful reproduction, and mediate both sexual motivation and behavior

gyrus (plural: gyri) bump or ridge on the cerebral cortex

hemisphere left or right half of the brain

heterozygous consisting of two different alleles

hindbrain division of the brain containing the medulla, pons, and cerebellum

hippocampus structure in the temporal lobe associated with learning and memory

homeostasis state of equilibrium—biological conditions, such as body temperature, are maintained at optimal levels

homozygous consisting of two identical alleles

hormone chemical messenger released by endocrine glands

hypothalamus forebrain structure that regulates sexual motivation and behavior and a number of homeostatic processes; serves as an interface between the nervous system and the endocrine system

identical twins twins that develop from the same sperm and egg

lateralization concept that each hemisphere of the brain is associated with specialized functions

limbic system collection of structures involved in processing emotion and memory

longitudinal fissure deep groove in the brain's cortex

magnetic resonance imaging (MRI) magnetic fields used to produce a picture of the tissue being imaged

This content is available for free at http://legacy.cnx.org/content/col11629/1.4

medulla hindbrain structure that controls automated processes like breathing, blood pressure, and heart rate

membrane potential difference in charge across the neuronal membrane

midbrain division of the brain located between the forebrain and the hindbrain; contains the reticular formation

motor cortex strip of cortex involved in planning and coordinating movement

mutation sudden, permanent change in a gene

myelin sheath fatty substance that insulates axons

neuron cells in the nervous system that act as interconnected information processors, which are essential for all of the tasks of the nervous system

neurotransmitter chemical messenger of the nervous system

occipital lobe part of the cerebral cortex associated with visual processing; contains the primary visual cortex

pancreas secretes hormones that regulate blood sugar

parasympathetic nervous system associated with routine, day-to-day operations of the body

parietal lobe part of the cerebral cortex involved in processing various sensory and perceptual information; contains the primary somatosensory cortex

peripheral nervous system (PNS) connects the brain and spinal cord to the muscles, organs and senses in the periphery of the body

phenotype individual's inheritable physical characteristics

pituitary gland secretes a number of key hormones, which regulate fluid levels in the body, and a number of messenger hormones, which direct the activity of other glands in the endocrine system

polygenic multiple genes affecting a given trait

pons hindbrain structure that connects the brain and spinal cord; involved in regulating brain activity during sleep

positron emission tomography (PET) scan involves injecting individuals with a mildly radioactive substance and monitoring changes in blood flow to different regions of the brain

prefrontal cortex area in the frontal lobe responsible for higher-level cognitive functioning

psychotropic medication drugs that treat psychiatric symptoms by restoring neurotransmitter balance

range of reaction asserts our genes set the boundaries within which we can operate, and our environment interacts with the genes to determine where in that range we will fall

receptor protein on the cell surface where neurotransmitters attach

recessive allele allele whose phenotype will be expressed only if an individual is homozygous for that allele

resting potential the state of readiness of a neuron membrane's potential between signals

reticular formation midbrain structure important in regulating the sleep/wake cycle, arousal, alertness, and motor activity

reuptake neurotransmitter is pumped back into the neuron that released it

semipermeable membrane cell membrane that allows smaller molecules or molecules without an electrical charge to pass through it, while stopping larger or highly charged molecules

soma cell body

somatic nervous system relays sensory and motor information to and from the CNS

somatosensory cortex essential for processing sensory information from across the body, such as touch, temperature, and pain

substantia nigra midbrain structure where dopamine is produced; involved in control of movement

sulcus (plural: sulci) depressions or grooves in the cerebral cortex

sympathetic nervous system involved in stress-related activities and functions

synapse small gap between two neurons where communication occurs

synaptic vesicle storage site for neurotransmitters

temporal lobe part of cerebral cortex associated with hearing, memory, emotion, and some aspects of language; contains primary auditory cortex

terminal button axon terminal containing synaptic vesicles

thalamus sensory relay for the brain

theory of evolution by natural selection states that organisms that are better suited for their environments will survive and reproduce compared to those that are poorly suited for their environments

threshold of excitation level of charge in the membrane that causes the neuron to become active

thyroid secretes hormones that regulate growth, metabolism, and appetite

ventral tegmental area (VTA) midbrain structure where dopamine is produced: associated with mood, reward, and addiction

Wernicke's area important for speech comprehension

Summary

3.1 Human Genetics

Genes are sequences of DNA that code for a particular trait. Different versions of a gene are called alleles—sometimes alleles can be classified as dominant or recessive. A dominant allele always results in the dominant phenotype. In order to exhibit a recessive phenotype, an individual must be homozygous for the recessive allele. Genes affect both physical and psychological characteristics. Ultimately, how and when a gene is expressed, and what the outcome will be—in terms of both physical and psychological characteristics—is a function of the interaction between our genes and our environments.

This content is available for free at http://legacy.cnx.org/content/col11629/1.4

3.2 Cells of the Nervous System

Glia and neurons are the two cell types that make up the nervous system. While glia generally play supporting roles, the communication between neurons is fundamental to all of the functions associated with the nervous system. Neuronal communication is made possible by the neuron's specialized structures. The soma contains the cell nucleus, and the dendrites extend from the soma in tree-like branches. The axon is another major extension of the cell body; axons are often covered by a myelin sheath, which increases the speed of transmission of neural impulses. At the end of the axon are terminal buttons that contain synaptic vesicles filled with neurotransmitters.

Neuronal communication is an electrochemical event. The dendrites contain receptors for neurotransmitters released by nearby neurons. If the signals received from other neurons are sufficiently strong, an action potential will travel down the length of the axon to the terminal buttons, resulting in the release of neurotransmitters into the synapse. Action potentials operate on the all-or-none principle and involve the movement of Na^+ and K^+ across the neuronal membrane.

Different neurotransmitters are associated with different functions. Often, psychological disorders involve imbalances in a given neurotransmitter system. Therefore, psychotropic drugs are prescribed in an attempt to bring the neurotransmitters back into balance. Drugs can act either as agonists or as antagonists for a given neurotransmitter system.

3.3 Parts of the Nervous System

The brain and spinal cord make up the central nervous system. The peripheral nervous system is comprised of the somatic and autonomic nervous systems. The somatic nervous system transmits sensory and motor signals to and from the central nervous system. The autonomic nervous system controls the function of our organs and glands, and can be divided into the sympathetic and parasympathetic divisions. Sympathetic activation prepares us for fight or flight, while parasympathetic activation is associated with normal functioning under relaxed conditions.

3.4 The Brain and Spinal Cord

The brain consists of two hemispheres, each controlling the opposite side of the body. Each hemisphere can be subdivided into different lobes: frontal, parietal, temporal, and occipital. In addition to the lobes of the cerebral cortex, the forebrain includes the thalamus (sensory relay) and limbic system (emotion and memory circuit). The midbrain contains the reticular formation, which is important for sleep and arousal, as well as the substantia nigra and ventral tegmental area. These structures are important for movement, reward, and addictive processes. The hindbrain contains the structures of the brainstem (medulla, pons, and midbrain), which control automatic functions like breathing and blood pressure. The hindbrain also contains the cerebellum, which helps coordinate movement and certain types of memories.

Individuals with brain damage have been studied extensively to provide information about the role of different areas of the brain, and recent advances in technology allow us to glean similar information by imaging brain structure and function. These techniques include CT, PET, MRI, fMRI, and EEG.

3.5 The Endocrine System

The glands of the endocrine system secrete hormones to regulate normal body functions. The hypothalamus serves as the interface between the nervous system and the endocrine system, and it controls the secretions of the pituitary. The pituitary serves as the master gland, controlling the secretions of all other glands. The thyroid secretes thyroxine, which is important for basic metabolic processes and growth; the adrenal glands secrete hormones involved in the stress response; the pancreas secretes hormones that regulate blood sugar levels; and the ovaries and testes produce sex hormones that regulate sexual motivation and behavior.

Review Questions

1. A(n) _____ is a sudden, permanent change in a sequence of DNA.
a. allele
b. chromosome
c. epigenetic
d. mutation

2. _____ refers to a person's genetic makeup, while _____ refers to a person's physical characteristics.
a. Phenotype; genotype
b. Genotype; phenotype
c. DNA; gene
d. Gene; DNA

3. _____ is the field of study that focuses on genes and their expression.
a. Social psychology
b. Evolutionary psychology
c. Epigenetics
d. Behavioral neuroscience

4. Humans have _____ pairs of chromosomes.
a. 15
b. 23
c. 46
d. 78

5. The _____ receive(s) incoming signals from other neurons.
a. soma
b. terminal buttons
c. myelin sheath
d. dendrites

6. A(n) _____ facilitates or mimics the activity of a given neurotransmitter system.
a. axon
b. SSRI
c. agonist
d. antagonist

7. Multiple sclerosis involves a breakdown of the _____.
a. soma
b. myelin sheath
c. synaptic vesicles
d. dendrites

8. An action potential involves Na^+ moving _____ the cell and K^+ moving _____ the cell.
a. inside; outside
b. outside; inside
c. inside; inside
d. outside; outside

9. Our ability to make our legs move as we walk across the room is controlled by the _____ nervous system.
a. autonomic
b. somatic
c. sympathetic
d. parasympathetic

10. If your _____ is activated, you will feel relatively at ease.
a. somatic nervous system
b. sympathetic nervous system
c. parasympathetic nervous system
d. spinal cord

11. The central nervous system is comprised of _____.
a. sympathetic and parasympathetic nervous systems
b. organs and glands
c. somatic and autonomic nervous systems
d. brain and spinal cord

12. Sympathetic activation is associated with _____.
a. pupil dilation
b. storage of glucose in the liver
c. increased heart rate
d. both A and C

13. The _____ is a sensory relay station where all sensory information, except for smell, goes before being sent to other areas of the brain for further processing.
a. amygdala
b. hippocampus
c. hypothalamus
d. thalamus

14. Damage to the _____ disrupts one's ability to comprehend language, but it leaves one's ability to produce words intact.
a. amygdala

This content is available for free at http://legacy.cnx.org/content/col11629/1.4

b. Broca's Area
c. Wernicke's Area
d. occipital lobe

15. A(n) _____ uses magnetic fields to create pictures of a given tissue.
a. EEG
b. MRI
c. PET scan
d. CT scan

16. Which of the following is not a structure of the forebrain?
a. thalamus
b. hippocampus
c. amygdala
d. substantia nigra

17. The two major hormones secreted from the pancreas are:
a. estrogen and progesterone
b. norepinephrine and epinephrine
c. thyroxine and oxytocin
d. glucagon and insulin

18. The _____ secretes messenger hormones that direct the function of the rest of the endocrine glands.
a. ovary
b. thyroid
c. pituitary
d. pancreas

19. The _____ gland secretes epinephrine.
a. adrenal
b. thyroid
c. pituitary
d. master

20. The _____ secretes hormones that regulate the body's fluid levels.
a. adrenal
b. pituitary
c. testis
d. thyroid

Critical Thinking Questions

21. The theory of evolution by natural selection requires variability of a given trait. Why is variability necessary and where does it come from?

22. Cocaine has two effects on synaptic transmission: it impairs reuptake of dopamine and it causes more dopamine to be released into the synapse. Would cocaine be classified as an agonist or antagonist? Why?

23. Drugs such as lidocaine and novocaine act as Na^+ channel blockers. In other words, they prevent sodium from moving across the neuronal membrane. Why would this particular effect make these drugs such effective local anesthetics?

24. What are the implications of compromised immune function as a result of exposure to chronic stress?

25. Examine **Figure 3.14**, illustrating the effects of sympathetic nervous system activation. How would all of these things play into the fight or flight response?

26. Before the advent of modern imaging techniques, scientists and clinicians relied on autopsies of people who suffered brain injury with resultant change in behavior to determine how different areas of the brain were affected. What are some of the limitations associated with this kind of approach?

27. Which of the techniques discussed would be viable options for you to determine how activity in the reticular formation is related to sleep and wakefulness? Why?

28. Hormone secretion is often regulated through a negative feedback mechanism, which means that once a hormone is secreted it will cause the hypothalamus and pituitary to shut down the production of signals

necessary to secrete the hormone in the first place. Most oral contraceptives are made of small doses of estrogen and/or progesterone. Why would this be an effective means of contraception?

29. Chemical messengers are used in both the nervous system and the endocrine system. What properties do these two systems share? What properties are different? Which one would be faster? Which one would result in long-lasting changes?

Personal Application Questions

30. You share half of your genetic makeup with each of your parents, but you are no doubt very different from both of them. Spend a few minutes jotting down the similarities and differences between you and your parents. How do you think your unique environment and experiences have contributed to some of the differences you see?

31. Have you or someone you know ever been prescribed a psychotropic medication? If so, what side effects were associated with the treatment?

32. Hopefully, you do not face real physical threats from potential predators on a daily basis. However, you probably have your fair share of stress. What situations are your most common sources of stress? What can you do to try to minimize the negative consequences of these particular stressors in your life?

33. You read about H. M.'s memory deficits following the bilateral removal of his hippocampus and amygdala. Have you encountered a character in a book, television program, or movie that suffered memory deficits? How was that character similar to and different from H. M.?

34. Given the negative health consequences associated with the use of anabolic steroids, what kinds of considerations might be involved in a person's decision to use them?

This content is available for free at http://legacy.cnx.org/content/col11629/1.4